明志科技大學材料工程系110學年四技專題製作競賽

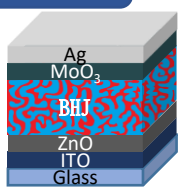
利用有機小分子來改善有機太陽能電池及有機光電感測器之性能

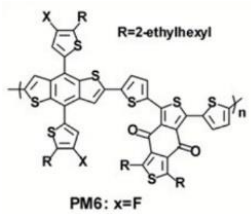
學生:U07187024張淳硯、U07187020翁培瑞、U07187052謝尚恩
指導教授:陳志平 教授

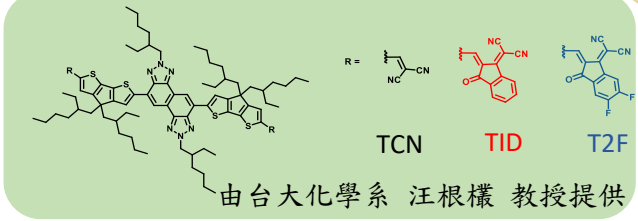
摘要

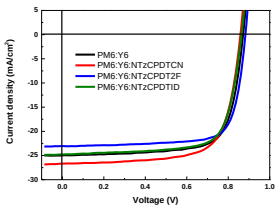
- 本實驗設計三元有機太陽能電池D/A/A結構，採用第三元材料非富勒烯小分 子結構來改善共混型態及幫助電荷傳遞，有效提升光電性質和元件穩定性。
- 透過改善分子間堆疊的方式來形成電子陷阱降低暗電流或改變主動層的厚度來進行元件的優化，並預期暗電流可以有明顯的下降，有效使響應度及電性有所提升為目標。

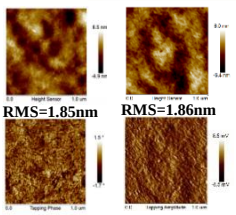
OPV



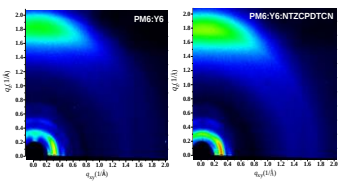


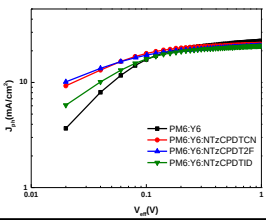






(a)PM6:Y6 (b)PM6:Y6:NTzCPDTCN

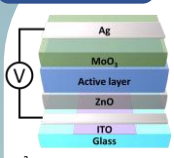


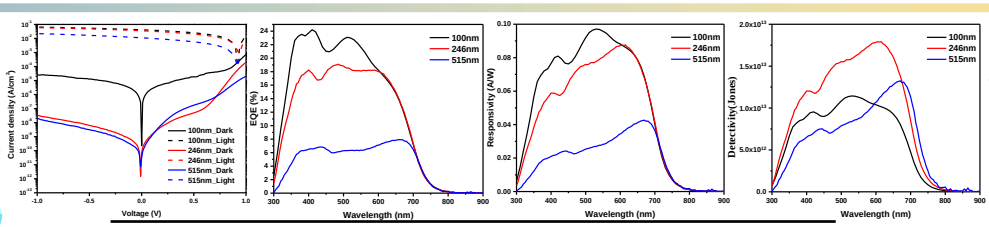


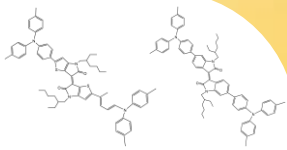
Active layer	J_{sc} (mA/cm²)	V_{oc} (V)	FF(%)	PCE(%)
PM6:Y6	24.5±0.52	0.87±0.001	72.9±0.69	15.6±0.29
PM6:Y6:NTzCPDTCN	26.1±0.13	0.88±0.001	72.0±0.2	16.5±0.02
PM6:Y6:NTzCPDT2F	24.9±0.05	0.87±0.002	74.0±0.8	15.9±0.05
PM6:Y6:NTzCPDTID	24.5±0.09	0.87±0.002	70.0±0.2	15.1±0.03

Active layer	J_{sat}(mA/cm²)	Maximum exciton generation rate,G_{max} ($*10^{28}m^{-3}s^{-1}$)	Exciton dissociation probability, P(E,T) (%)
PM6:Y6	27.81	1.74	87.6
PM6:Y6:NTzCPDTCN	24.22	1.51	92.6
PM6:Y6:NTzCPDT2F	23.86	1.49	90.2
PM6:Y6:NTzCPDTID	26.08	1.43	84.4

OPD







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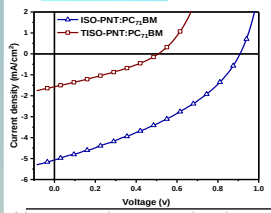
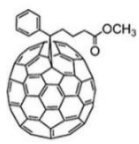


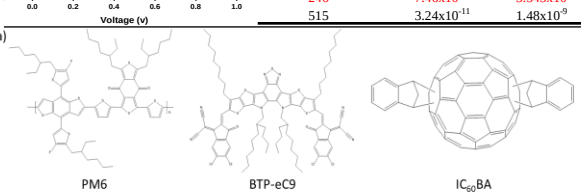
Device	J_{SC}(mA/cm²)	V_{OC} (V)	FF(%)	Efficiency(%)
ISO-PNT:$PC_{71}BM$	4.7±0.29	0.92±0.02	35.1±0.86	1.523±0.17
TISO-PNT:$PC_{71}BM$	1.04±0.02	0.51±0.01	32.3±0.17	0.171±0.01

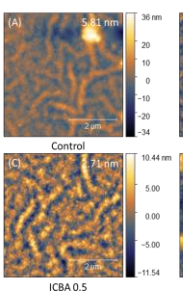
Active layer Thickness(nm)	Dark current density(A/cm²) @0V	Dark current density(A/cm²) @-1V	EQE(%) Max	Active layer Thickness(nm)	Responsivity(A/W) Max	Detectivity(Jones) Max
100	$2.25x10^{-10}$	$2.47x10^{-5}$	24.2	100	0.1	$1.14x10^{13}$
246	$7.46x10^{-11}$	$3.545x10^{-8}$	19.1	246	0.088	$1.8x10^{13}$
515	$3.24x10^{-11}$	$1.48x10^{-9}$	7.9	515	0.042	$1.3x10^{13}$

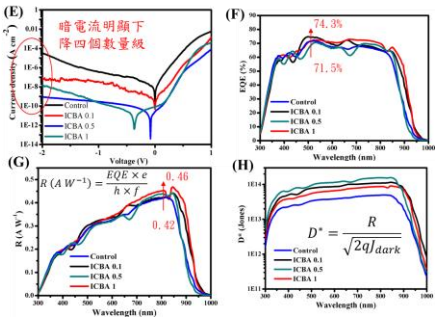


$PC_{71}BM$

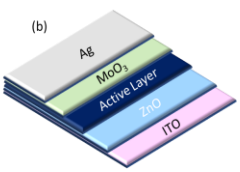
(a)







(b)



結論

- 高效率PM6:Y6系統中加入第三元材料，優化主動層相分離有效使性能提升，使效率從15%提升到16%。
- 使用ISO-PNT材料以主動層厚度246nm為最佳厚度，進而實現低暗電流與高探測比。
- 添加 IC60BA 富勒烯材料，填補材料間的空隙，使表面粗糙度的有效減少，造成載子傳輸的優化。